FORM PTO-1390 (REV 10-94) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 8436.63USWO

U S APPLICATION NO (If known, see 37 C F R. 1 5): unknown 09/319764

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/NZ97/00168	12 December 1997	12 December 1996

TITLE OF INVENTION

VALVE SYSTEM FOR SERVO CONTROL OF FLUID FLOWS

APPLICANT(S) FOR DO/EO/US

Bradley HOUGHTON, Peter JEROMSON, Jamie WILKINSON, Peter BARNES, Giscard RUTTEN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(l).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.

8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. [X] An unsigned oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.
    [ ] A SECOND of SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information: Copy of US International Search Report; copy of International Preliminary Examination Report w/amended claims and drawings

U.S. APPLICATION NO (If known, see 37 C F R. 1 5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
unknown 09/319764	PCT/NZ97/00168	8436.63USWO

17. [X] The following fees are submitted:

	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492(a) (1)-(5)):	
Search Report has been prepared by the EPO or JPO **$840.00**	
International preliminary examination fee paid to U.S. Patent and Trademark Office (37 CFR 1.492(a)(1)) **$670.00**	
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) **$760.00**	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(3)) paid to USPTO **$970.00**	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) **$96.00**	

ENTER APPROPRIATE BASIC FEE AMOUNT =				**$ 760.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				**$ 0.00**	
CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE	
Total claims	28	-20 =	8	X **$18.00**	**$ 144.00**
Independent claims	3	-3 =	0	X **$78.00**	**$ 0.00**
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ **$260.00**	**$ 0.00**
TOTAL OF ABOVE CALCULATIONS =					**$ 904.00**
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).					**$ 0.00**
SUBTOTAL =					**$ 904.00**
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f).				+	**$ 0.00**
TOTAL NATIONAL FEE =					**$ 904.00**
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property				+	**$ 0.00**
TOTAL FEES ENCLOSED =					**$ 904.00**
				Amount to be: refunded	**$**
				charged	**$**

a. [X] Check(s) in the amount of $904.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 13-2725.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
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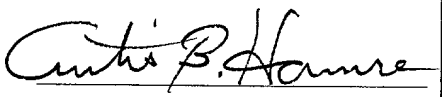

SIGNATURE

Curtis B. Hamre
NAME

29,165
REGISTRATION NUMBER

S/N unknown PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	HOUGHTON et al.	Docket No.:	8436.63USWO
Serial No.:	unknown	Filed:	concurrent herewith
Int'l Appln No.:	PCT/NZ97/00168	Int'l Filing Date:	12 December 1997
Title:	VALVE SYSTEM FOR SERVO CONTROL OF FLUID FLOWS		

CERTIFICATE UNDER 37 CFR 1.10
'Express Mail' mailing label number: EL353245666US
Date of Deposit: 11 June 1999
I hereby certify that this correspondence is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C . 20231.

By: Tyrone Ross
Name: Tyrone Ross

PRELIMINARY AMENDMENT

Box PCT
Assistant Commissioner for Patents
Washington, D. C. 20231

Dear Sir:

In connection with the above–identified application filed herewith, please enter the following preliminary amendment, which is based on the amendments filed during the international phase, on 17 February 1999, a copy of which is enclosed herewith:

IN THE ABSTRACT

Insert the attached Abstract page into the application as the last page thereof.

IN THE SPECIFICATION

A courtesy copy of the present specification is enclosed herewith. However, the World Intellectual Property Office (WIPO) copy should be relied upon if it is already in the U.S. Patent Office.

IN THE CLAIMS

Claim 7, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 8, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 9, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 11, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 12, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 13, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 14, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 16, line 1, replace "Claims 13 or 14" with —Claim 13—.

Claim 17, line 1, replace "any one of Claims 13 to 15" with —Claim 15—.

Claim 18, line 1, replace "any one of Claims 13 to 16" with —Claim 15—.

Claim 20, line 1, delete "or Claim 18".

Claim 22, line 1, delete "or Claim 20".

Claim 23, line 1, replace "Claims 17 to 21" with —Claim 19—.

Claim 24, line 1, replace "any one of the preceding claims" with —Claim 1—.

Claim 26, line 1, replace "any one of Claims 19 to 24" with —Claim 19—.

Claim 27, line 1, replace "any one of the preceding claims" with —Claim 1—.

Please cancel claims 29–32.

REMARKS

The above preliminary amendment is made to remove multiple dependencies from claims 7–9, 11–14, 16–18, 20, 22–24, and 26–27. Claims 1–28 are presented for examination.

A new abstract page is supplied to conform to that appearing on the publication page of the WIPO application, but the new Abstract is typed on a separate page as required by U.S. practice.

Applicants respectfully request that the preliminary amendment described herein be entered into the record prior to calculation of the filing fee and prior to examination and consideration of the above–identified application.

If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicants' primary attorney–of record, Brian H. Batzli (Reg. No. 32,960), at (612) 336–4755.

Respectfully submitted,

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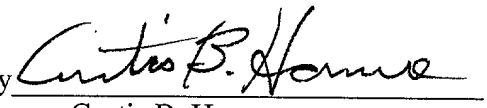
Dated: 11 June 1999

By 

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BHB/smh

VALVE SYSTEM FOR SERVO CONTROL OF FLUID FLOWS

The present invention relates to valves for controlling the flow of fluids in a fluid supply system. More particularly, it relates to valves suitable for active servo control of fluid flows. Further, in particular, it relates to valves for active servo control of fluid flows in a fluid mixing unit.

BACKGROUND OF THE INVENTION

Valve systems suitable for being electrically controlled and actuated are known for a wide variety of applications. These add the many advantages of control electronics and computing to their applications.

One such application, is the control of flow for shower mixers, hand basin mixers, and the like.

A commonly used conventional electrically controllable flow valve includes a conventional faucet valve and an electric motor to actuate the spindle of the faucet valve. The electric motor turns the spindle to axially move the disc of the faucet valve and restrict flow emerging from the disc ring of the faucet valve. Typically, multiple revolutions of the spindle are required to actuate the disk through its working range. Also the spindle is mounted and moved by means of a thread arrangement which introduces friction. Therefore, this type of valve is not well suited to servo control. Also, movement of the disk to close the valve must work against the supply pressure of the fluid.

Accordingly, it is an object of the present invention to provide a fluid control valve which overcomes or obviates the disadvantages of existing systems, or at least to provide the public with a useful choice.

It is also an object of an embodiment of the present invention to provide a fluid control valve adapted to servo control the flow of fluid through the valve, or at least to provide the public with a useful choice.

It is an object of an embodiment of the present invention to provide a servo controlled mixing of supplied fluids in given ratios, or at least to provide the public with a useful choice.

It is an object of an embodiment of the present invention to provide an actively controlled shower mixer which employs temperature feedback, or at least to provide the public with a useful choice.

SUMMARY OF THE INVENTION

According to an aspect of the present invention there is provided a valve body; a first member defining at least one first aperture communicating with at least one respective fluid supply or outlet; and a second member defining at least one second aperture; wherein the first and second members are arranged in sealing contact and are variably alignable so that first and second apertures are, in turn, variably alignable such that fluid may flow through the at least one first aperture only when there is an overlap between first and second apertures, and such that the flow through the or each second aperture may be varied by variable alignment of the first and second apertures.

Preferably, the first and second members are variably alignable by rotation. Preferably, this rotation may be actuated by a stepper motor which may be controlled by a controller including a microprocessor, preferably, receiving parameter feedback from at least one sensor.

According to another aspect of the present invention, there is provided a fluid control valve communicating with at least two fluid supplies, including:

- at least two valve subunits, each subunit including a first member having at least one first aperture and a second member having at least one second aperture, and wherein fluid flow from the at least one first aperture is controllable by variable alignment of the first and second members;

- at least one electric motor, preferably a stepper motor, arranged to actuate the variable alignment of first and second members for one or more valve subunits.

Preferably, the valve includes a controller including a microcontroller which may receive parameter feedback from at least one sensor.

According to another aspect of the present invention, there is provided a fluid control valve as claimed in any one of the preceding claims, including a single first aperture and at least two second apertures arranged such that variable alignment of the first and second members allows variable diversion of fluid through each of the at least two second apertures.

According to another aspect of the present invention, there is provided a fluid control valve including at least two outlets; at least two fluid control valves as immediately above, wherein one second aperture of each fluid control valve communicates with one or the other of the two outlets.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURES 1 & 1A: Respectively show top and bottom views of a part of a valve in accordance with an embodiment of the present invention.

FIGURE 2: Shows a side view of the part shown in Figures 1 and 1A.

FIGURE 3: Shows a plan view of another part of a valve according to the same embodiment of the present invention.

FIGURE 4: Shows a side view of the parts shown in Figure 3.

FIGURE 5: Shows a part of a valve corresponding to the parts shown in Figures 1 and 2 according to an alternative embodiment of the present invention.

FIGURE 6: Shows a side plan view of a part shown in Figure 5.

FIGURE 7: Shows a gasket which corresponds to the part of the valve shown in Figures 1, 1A and 2.

FIGURE 8: Shows a side view of the gasket shown in Figure 7.

FIGURES 9 & 9A: Shows part of a gasket used to seal either of the parts shown in Figures 1 and 2 or 5 and 6.

FIGURES 10 & 10A: Shows two reinforcement members for the gasket shown in Figure 9;

FIGURE 11: Shows a valve assembly incorporating the parts shown in Figures 1 to 10 of either embodiment.

FIGURE 12: Shows a servo valve system according to an embodiment of the present invention and incorporating the valve assembly shown in Figure 11.

FIGURE 13: Shows a servo valve system according to an alternative embodiment and incorporating the valve assembly shown in Figure 11.

FIGURE 14: Shows a servo valve system according to an alternative embodiment of the present invention.

FIGURE 15: Shows the layout of a user interface for a servo valve system according to an alternative embodiment of the present invention.

FIGURE 16: Schematically shows a mixing system according to an embodiment of the present invention.

FIGURES 17-20: Show a combination mixing and diverting servo valve system according to a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 show an inlet valve member 1 which, in use, is aligned perpendicular to a flow of fluid through the valve. The inlet valve member 1 includes two conduits 2 and 3 through which fluid passes when the valve is open. Typically, these conduits have a cross section that is sectorial or elliptical at one face of the valve member 1 and circular at the other, although any suitable cross sectional shape may be substituted. The apertures are, typically, formed circular at the face of the inlet valve member 1 which is in contact with the fluid supply and the size of the circles are minimised, within constraints of required flow. In use, only the apertures and a minimal area around the apertures are in contact with the fluid supply to minimise pressure being exerted on the inlet valve member 1 which would increase friction between the inlet valve member 1 and the outlet valve member 10, described below. Also, typically, the conduits 2 and 3 are

positioned inward from the periphery of the valve member 1 to provide an area of the valve member 1 peripheral to the conduits against which another member may abut to seal the conduits 2 and 3 when required. However, suitable alternative sealing arrangements will be apparent to those skilled in the art.

The conduits 2 and 3 may have different relative sizes to account for relative differences in supply pressures or viscosity, for example.

The inlet valve member may typically have a recessed region 5 formed in the contact side 6 of the inlet valve member 1 and grooves 6a to reduce friction with any flat surface in contact with the contact side 6 of the inlet valve member 1. Such friction reduction measures reduce the actuation torque required by the valve. The edges of the inlet valve 1 may, typically, be bevelled to prevent chipping of the edges of the valve member 1.

The inlet valve member includes alignment tabs 7 with which it may be held in a given orientation.

Figures 3 and 4 show an output valve member 10. The valve member 10 has a contact surface 11 which may be flat so that the output valve member 10 may be sealingly abutted against the contact side of the inlet valve member 1 in use to seal the conduits 2 and 3 when required.

The output valve member 10 is of the form of a disk with a removed sector 12. It will be apparent to those skilled in the art that alternative shapes to a removed sector may suitably be substituted and that the shape may be optimised for particular applications. In use, the output valve member 10 is abutted and aligned with the inlet valve member 1 and depending on its orientation with respect thereto, variably impedes the flow of fluid emerging from the conduits 2 and 3. The flow will be completely impeded and the conduits 2 and 3 sealed when the cutout portion 12 of the output valve member 10 does not overlap either of the conduits 2 or 3. The flow of fluid through each of the conduits 2 and 3 can be varied from nil

flow to an unimpeded flow or a controlled ratio of flow through each conduit. Thus, the output valve member 10 and input valve member 1 may be combined to form a mixing valve. Alternatively, they may be reversed and combined to form a diverting valve. Alternatively, an inlet member having only one aperture may be used to control the flow of a single fluid, or both apertures of the inlet member 1 may communicate with a single fluid supply for the same purpose.

Typically, each conduit 2 and 3 communicates with a separate fluid supply conduit, not shown, and the output of the valve communicates with a single output conduit so that the valve allows the variable mixing of the fluids from the two supply conduits.

The output valve member 10 includes actuation recesses 13 by which it may be rotated.

The size of the cutout sector 12 in conjunction with the size of the apertures 2 and 3 determines the maximum flow rate for given fluids at given temperatures and pressures.

Figures 5 and 6 show an inlet valve member which includes conduits having a sectorial cross-section of greater area than those of the inlet valve member shown in Figures 1 and 2. It will be clear to those skilled in the art that other conduit sizes and shapes may be substituted as applicable to given applications of the valve.

Figures 7 and 8 show a seal, or gasket, 85 used in conjunction with the inlet valve member 1 shown in Figures 1, 1A and 2.

Figures 7 and 8 show a gasket 85 used to seal the inlet valve member 1 shown in Figures 1, 1A and 2.

Figures 9 to 12 show gasket elements 28 and 29, which are combined to form a gasket for sealing inlet valve members 1 shown in Figures 5 and 6. The gaskets are, typically, formed from silicon, rubber or

other suitable deformable material, and gasket members 29 are, typically, formed from plastic and serve the purpose of reinforcing the gasket member 28.

Figure 11 shows a valve assembly 19, including the inlet valve member 1 and outlet valve member 10 of either of the embodiments described above. These valve members are fitted inside a valve chassis 20. The cut-away sector 12 of the outlet valve member 10 and the valve chassis 20 define an outlet aperture. The valve chassis 20 is open at one end to form a valve chassis inlet 21. A valve chassis outlet 22 is formed in the side of the valve chassis 20. In use, the valve assembly 19 is fitted into a valve housing described below. An O-ring 23 is used to seal the valve assembly 19 in the valve housing.

The valve assembly 19 includes a spindle assembly 24, which engages the actuation recesses 13 of the outlet valve member 10. The outlet valve member 10 can be rotated by rotation of the spindle assembly 24, which includes a spline 25 formed at one end to facilitate turning of the spindle assembly 24.

The inlet valve member 1 is, typically, held in fixed alignment by the alignment tabs 7 which engage corresponding alignment recesses, not shown, in the valve assembly chassis 20. The spindle assembly 24 is sealed within the valve assembly chassis 20 by use of O-rings and washers.

The gasket 85 or that formed from gasket members 28 and 29 is fitted into the inlet end of the valve assembly chassis 20.

The working of the valve assembly is illustrated below with reference to hot and cold water, each being supplied by one separate conduit 2 or 3, as would be the case with an application such as a shower temperature control mixing valve.

The output valve member 10 is initially orientated so as to cover or seal both of the apertures 2 and 3 of the inlet valve member 1. The spindle

24 is then turned in an opening direction to initially uncover part of the aperture 2, for example, which is supplied with cold water. Continued turning in the same direction increasingly uncovers the aperture 2. Eventually, continued turning will uncover the other aperture 3 to which hot water is supplied and partially cover the aperture 2. The ratio of hot and cold water may be adjusted by turning the spindle 24 in the same direction or in the opposite direction. Having sectorial inlet and outlet apertures, provides that the valve has a linear flow response with respect to rotational angle.

At a mid point, equal portions of each aperture are uncovered and depending on the chosen shape and size of the conduits 2 and 3 and sector 12, this may correspond to partial covering of both apertures 2 and 3.

Further turning may result in only the aperture 3 being uncovered and only hot water being supplied to the valve assembly outlet 20.

Figure 12 shows a side view of a servo valve system 30, which includes the valve assembly described above.

The servo valve system 30 also includes an inlet manifold 31 having two inlets, one of which 32 is shown cross sectionally in Figure 13, and the other of which is positioned directly behind the dividing wall 33, as shown in Figure 13. The dividing piece 8 of the inlet valve member 1, which divides the two apertures 2 and 3 is aligned with the dividing wall 33. ~~The~~ gasket ~~26~~ is aligned accordingly. It may be preferable that the gasket ~~26~~ or the inlet manifold 31 are shaped like gasket 85 so that only the apertures of the inlet valve member 1 are in contact with the fluid supply as otherwise force exerted on the inlet valve member 1 causes increased friction between the inlet valve member 1 and the outlet valve member 10 which requires an increase actuation torque.

The servo valve system 30 includes an outlet pipe 34 connected at the outlet 22 of the valve assembly 19. Typically, but not necessarily, the outlet pipe 34 is integrally formed from the servo valve system housing 35.

The valve assembly 19 is secured in the housing 35 with an annular cap 36 and sealed at the top with the O-ring 23.

The inlet manifold 31 is sealed to the housing 35 with an O-ring 37.

The servo valve system 30 includes a stepper motor 38, or some other automated driving device such as a DC motor, AC motor or hydraulic motor, to actuate the spindle 24 at the spline 25 through a gear box 39. It will be apparent to those skilled in the art that a wide variety of stepper motors may be used with suitable gear boxes or that a spline 25 of suitable diameter may eliminate the need for a gearbox in some cases. By the use of the friction reducing measures described above, a minimally sized stepper motor may be used reducing the size and required resources of the device.

The servo valve system 30 may include one or more sensors, not shown, in the input manifold 31, but more particularly in the output pipe 34 to provide feedback for the control of the servo valve system 30.

The sensors may include temperature sensors. For example, a thermistor may be inserted through the side of the pipe 34 to monitor temperature of the water, say, in the outlet pipe and to allow suitable adjustment by the stepper motor 38 to control temperature of water in the outlet pipe 34 in the case where different temperature fluid supplies are connected to the inlet manifold 31.

Figure 13 shows a servo valve system 40 according to an alternative embodiment of the present invention. The servo valve system 40 differs from the servo valve system 30 described above, only by the inclusion of an extra output pipe 41 which may be opened or closed by way of a solenoid valve 42. In one application, the output pipe 34 supplies a hand held shower head and the output pipe 41 supplies a midriff height shower jet. The solenoid valve 42 opens and closes water supplied to the hand held shower head as desired.

Figure 14 shows a side view of a servo valve system 50 according to another aspect of the present invention.

The servo valve system 50 includes two individual valves such as 51 shown each being supplied by individual inlet pipes, such as 52 shown.

The valves consist of conventional apertured ceramic disks mounted in a chassis with two outlets on opposite sides of the chassis.

The ceramic disks each include two opposing apertures, typically sectorial in shape. To open the valve, one of the disks is rotated by way of the spindle so that the apertures of both disks overlap.

The outlets of both valve assemblies feed a single intermediary conduit 55. Each valve is actuated at the respective spline 54 of the respective spindle 53 by a gearbox respective 61 and a respective stepper motor 62.

As each valve controls the inflow of fluid from a separate inlet, the ratio of fluids from each inlet as well as the total flow from both inlets can be adjusted.

Typically, the stepper motors are controlled such that once a desired flow in the intermediary pipe 55 is achieved, an adjustment to one valve is accompanied by a negative adjustment of the other, so that the mix of fluid in the intermediary pipe 55, or temperature, can be adjusted whilst the pressure is maintained. This may be modified to take account of relative differences in supply pressures that occur where non mains pressure water supply systems are used.

The servo valve system 50 also includes an outlet manifold 56 which, typically, has three final outlets such as 57 and 58, each including a solenoid valve such as 59 and 60.

One embodiment incorporating this aspect of the present invention is intended for use with a shower unit, which has two fixed shower heads, one at head height and one at mid drift height, for example. This embodiment is supplied with hot and cold water at separate inlets and includes a thermistor

inserted into the intermediary chamber 55 to provide feedback on temperature for appropriate control of the two valves such as 51. Thus, a drop in one or the other of the water supplies will be compensated in terms of temperature without the need for a pressure feedback, although this may be included if desired.

This embodiment is able to compensate for changes in supplied pressure of either or both the hot and cold water so that a constant desired temperature and constant desired pressure is provided at the shower heads. It may also compensate for changes in pressure at one or two of the final outlets such as 57 and 58 in the event that one or two of the other final outlets are opened or closed.

One preferred embodiment of the present invention is directed for use in bathroom showers where it provides relatively constant temperature water for shower heads. It will be clear to those skilled in the art that the bathroom shower is merely an example application and that many analogous applications of this embodiment exist and that the mixing of water of different temperatures may be analogous to the mixing of fluids having other physical or chemical properties. A few examples are ph, viscosity, dielectric constant, or content of a given chemical or biological agent.

The bathroom shower mixing system is supplied with two fluids, hot and cold water at given pressures. These are mixed by a servo valve system according to any of the embodiments described above and information on the temperature of the mixed fluid is fed back to the controller of the servo valve system. In the case of the servo valve system 50 being used, information on pressure can be estimated by the known position of the stepper motors and so pressure may be maintained.

The temperature sensors are typically negative temperature coefficient sensors. Some inherent nonlinearity of the temperature signals may be partially compensated with the sensor electronics before quantisation by the microprocessor. The microprocessor contains software that compares the measured temperature with a predefined reference

temperature. From this, and with an appropriate control algorithm, again, the microprocessor determines the required position of the stepper motors, and therefore, the valve members 1 and 10. It will be understood by those skilled in the art that calibration of the system will be necessary and suitable calibration will be apparent.

To maintain excellent speed and torque characteristics whilst maintaining good angular resolution and minimal microprocessor resource, the stepper motors are, preferably, operated at two speeds using two different stepping modes.

The motor is "full-stepped" for large displacements. This optimises the speed and torque response.

The motor is "half-stepped" for temperature adjustments. This optimises the resolution of movements.

The motors are half-stepped at the start of an acceleration from rest and later full-stepped. Similarly, the motors are half-stepped at the end of a deceleration to rest and after full-stepping. These measures reduce mechanical shock and overcome inertia of the motor, gearbox and valve assembly.

The mixer system also includes protection against the valve being left open in the event of loss of electrical power. Two methods are employed in the preferred embodiment. One method includes the use of batteries which store enough energy to close the valve assembly when power loss is detected. The other method includes the use of solenoids that require power to remain open and, thus the flow is shut off when the power fails.

Figure 15 shows a user interface 60 for a preferred embodiment of the bathroom shower mixing system that includes the servo valve system 50.

The user interface 60 includes an LCD display for displaying the desired and/or actual water temperature and ± 62 button system for adjusting the desired water temperature.

A set of three buttons 63 are also included to switch on/off a shower rose, perhaps, fixed at head height, shower jets, perhaps, fixed at midriff height and a hand held shower rose. The set of buttons 64 are included for user programmable preset functions for, perhaps, temperature and combinations of outlets and lights. Button 65 controls an economy mode which may reduce water flow by 25% or 50%. Button 66 may be used to set the shower duration with increments of 30 seconds. Button 67 switches on/off a "Swedish" cycle which fluctuates the shower temperature between hot and cold.

Figure 16 schematically shows the operation of a servo valve system in accordance with an embodiment of the present invention.

Information on a desired value of a given parameter, such as temperature of fluid leaving the valve system, is received from the user by the user interface 71. This information is fed to the system controller 72. The system controller 72 receives information from a sensor at the output of the valve system and includes an analog to digital converter to quantify the parameter value sensed by the sensor. The position of the stepper motor and gearbox 75 is then calculated by the module 74 and then converted to a stepper sequence by the stepper sequencer 81. The stepper motor and gearbox 75 are then driven by the stepper driver 76 to the required position. By actuation of the stepper motor and gearbox, the mixing assembly 77 is placed in a suitable position to mix the inlet fluids 78 and 79 to form the outlet fluid 80. Information on the given parameter is then fed back to the microcontroller and the process repeated by way of adjustment.

It will be apparent to those skilled in the art that an alternative embodiment to those described above may include a valve assembly 19 used in reverse where water is fed into the outlet 22 from a single supply and from there diverted into either of the conduits 2 or 3 of the, now, outlet

member.

Figures 17 to 20 show a further embodiment of the present invention. This is a combined valve provided to control temperature, pressure and also direct flow between alternative outlets. The fluid control valve 90 shown in Figures 17 to 20 may control the flow hot and cold water independently to alternative outlets. The valve 90 may comprise a main body portion 91 having hot and cold water inlets 92 and 93 respectively. Valve members 94 and 95 may be provided in cooperating pairs acting to independently control the flow of hot and cold water respectively. These cooperating pairs may be prepared as pairs of valve members in accordance with valve members 1 and 10, although it will be preferable that the inlet valve member/and outlet valve member 10 are swapped so that the "outlet" valve member 10 now communicates directly with the fluid supply.

It can be seen that the outlet from the valve members 94 and 95 allows flow into either one of two mixing chambers 96 and 97, each connected with separate outlets 98 and 99. Further, control of the valve members 94 and 95 and the relative rotation of one with the other is provided by stepper motors 100 and 101. These stepper motors may be controlled by a controller which may receive feedback information on temperature, or some other fluid parameter, at the outlet.

It can be seen that a valve of this type may be mounted on an installation to divert flow between a shower head or a bath spout, for example. The temperature at the outlet may be controlled through independent control over the flow of hot and cold fluid into the mixing chambers through the valve members 94 and 95 by control of the stepper motors 100 and 101. Furthermore, if the valve members 94 and 95 are independently controlled, the flow rate from the valve may be controlled by controlling the degree to which each of these valve members are opened.

This assembly allows servo control over the direction, flow rate and temperature fluid in a single installation.

In all the valve assemblies, filters may be incorporated either within the valve or upstream to inhibit the entry of particular matter into the valve which may affect the valve control.

Although the above described embodiments have been described in reference to the mixing of two fluids, it will be apparent to those skilled in the art that the valve or valve systems may find useful application in controlling the flow of a single fluid and that this is merely a simpler application than controlling the flow of two fluids. One possible example of a single fluid application is in the control of water supplied to a urinal. For single fluid applications, the valve member 1 described above may be used with both apertures 2 and 3 communicating with a single fluid supply. An alternative embodiment includes an inlet valve member, not shown, similar to the inlet member 1, but consisting of only one inlet aperture.

The present invention provides an effective servo valve system which can actively compensate for fluctuations in relative supply of two or more fluids. This may, for example, be desirable for shower mixers where the hot and cold water supply pressures may fluctuate due to use in another part of a building, for example.

Another embodiment of the present invention provides a servo valve system, which may actively adjust for flow or relative and absolute changes in the supply pressure of two or more supplied fluids. This may, for example, be useful for shower mixing units where constant flow as well as constant temperature is desired. This may be particularly useful where the shower mixer has multiple outlets and adjustment of supply pressure is necessary to compensate for sudden changes in outflow through the outlets.

The present invention provides servo control valve systems which incorporate stepper motors which are, by their nature, suited to servo control applications and eliminate the need for systems for monitoring the position of the valves or motors.

Where in the foregoing description, reference has been made to specific components or integers of the invention having known equivalents then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by way of example and with reference to possible embodiments thereof, it is to be understood that modifications or improvements may be made thereto without departing from the scope or spirit of the invention, as defined in the appended claims.

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Art = 34.

CLAIMS

1) A fluid control/mixing valve including:

- a valve body;
- a first disk member defining at least two first apertures communicating with at least two corresponding fluid supplies or outlets;
- a second disk member defining at least one second aperture;
- wherein the first and second disk members are arranged in sealing contact and are variably alignable in a coaxial, constrained manner, so that the first and second apertures are, in turn, variably alignable such that fluid may flow through the at least two first apertures only when there is an overlap between first and second apertures, and such that the flow through the or each second aperture may be varied by variable coaxial alignment of the first and second apertures.

2) A fluid control/mixing valve as claimed in Claim 1 wherein the torque between the first and second disk members is such that their relative coaxial rotation may be effected by means of a stepper motor, DC motor or the like.

3) A fluid control valve as claimed in Claim 1, wherein the first disk member includes at least one sealing region suitable to facilitate sealing between the first and second disk members.

4) A fluid control valve as claimed in Claim 2, wherein the first disk member includes at least one friction reducing region consisting of an indented region to reduce the area of contact between the first and second disk members.

5) A fluid control valve as claimed in Claim 3, wherein the at least one friction reducing region is substantially defined by a sealing region arranged around the periphery of the first disk member.

6) A fluid control valve as claimed in Claim 4, wherein the at least one friction reducing region includes at least one region extending radially to the periphery of the first member.

7) A fluid control valve as claimed in any one of the preceding claims, wherein the or each first aperture is substantially sector shaped.

8) A fluid control valve as claimed in any one of the preceding claims, wherein the or each second aperture is substantially sector shaped.

9) A valve as claimed in any one of the preceding claims, wherein the valve is arranged such that variable alignment of the first and second disk members is brought about by relative rotation of the first and second members.

10) A valve as claimed in Claim 8, wherein the second disk member is rotatable within a cylindrical region.

11) A valve as claimed in any one of the preceding claims, wherein the second disk member is substantially in the form of a disk having one or more removed sector(s).

12) A valve as claimed in any one of the preceding claims, wherein the first disk member is substantially of the form of a disk having at least one removed interior region.

13) A valve as claimed in any one of the preceding claims including a pipe having an internal bore into which the first disk member sealingly fits such that fluid is constrained to passing only through the inlet apertures.

14) A valve as claimed in any one of the preceding claims including at least one electric motor arranged to actuate the relative alignment of the first and second disk members.

15) A fluid control/mixing valve communicating with at least two fluid supplies, including:

- at least two valve subunits, each subunit including a first disk member having at least one first apertures and a second disk member having at least second apertures, and leading to one outlet, and wherein fluid flow from the at least one first aperture is controllable by variable coaxial, constrained alignment of the first and second disk members;

- at least one electric motor arranged to actuate the variable alignment of first and second disk members for one or more valve subunits simultaneously and in a manner adapted to control and provide a specified fluid characteristic; and

- an outlet manifold having one or more manifold outlets.

16) A valve as claimed in Claims 13 or 14, wherein the at least one electric motor is a stepper motor.

17) A valve as claimed in any one of Claims 13 to 15, including at least one gear to facilitate the actuation for variable alignment of the first and second disk members.

18) A valve as claimed in any one of Claims 13 to 16 including a controller to control the at least one electric motor and thereby the flow from the or each of the first apertures.

19) A valve as claimed in Claim 17, wherein the controller includes a microcontroller.

20) A valve as claimed in Claim 17 or Claim 18, including at least one sensor to sense at least one parameter of the fluid(s).

21) A valve as claimed in Claim 19, wherein the controller is arranged to control the flow from the or each of the first apertures and to receive information from the at least one sensor to control at least one of the at least one parameter of fluid leaving the valve.

22) A valve as claimed in Claim 19 or Claim 20, wherein the at least one given parameter includes temperature information.

23) A valve as claimed in any one of Claims 17 to 21, wherein the controller is arranged suitably to estimate flow taking into account at least the position of the stepper motor.

24) A valve as claimed in any one of the preceding claims, including an outlet manifold having two or more manifold outlets.

25) A valve as claimed in Claim 23, wherein the one or more manifold outlets include valves to allow or prevent flow from the respective manifold outlets.

26) A valve as claimed in any one of Claims 19 to 24, including a user interface adapted to receive information on the at least one parameter of fluid leaving the valve.

27) A fluid control valve as claimed in any one of the preceding claims, including a single first aperture and at least two second apertures arranged such that variable alignment of the first and second members allows variable diversion of fluid through each of the at least two second apertures.

28) A fluid control valve including:

- at least two outlets;
- at least two fluid control valves as claimed in Claim 26, wherein one second aperture of each fluid control valve communicates with one or the other of the two outlets.

29) A valve as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

30) A valve assembly substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

31) A servo valve system substantially as hereinbefore described with reference to any one of the embodiments shown in the accompanying drawings.

32) A combined mixing and diverting valve substantially as hereinbefore described with reference to Figures 17 to 20.

LC:VO:TSPEC43930

File Ref: 501578-142

ABSTRACT OF THE DISCLOSURE

The present invention provides a mixing valve (30) suitable for electric motor (38) actuation, particularly stepper motor actuation. It also provides a servo mixing valve system, which includes stepper motors for actuation and optionally includes a solenoid switched outlet manifold and a combination mixing and dye. The present invention also provides an actively controlled bathroom shower mixing system including temperature formation feedback.

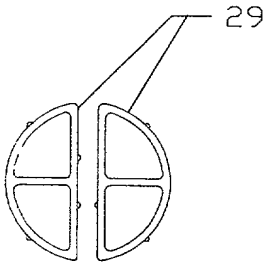
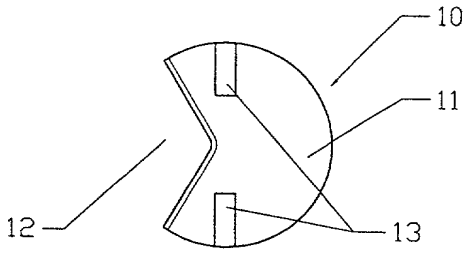


Figure 10



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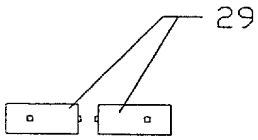

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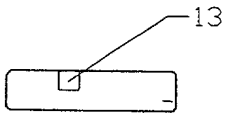

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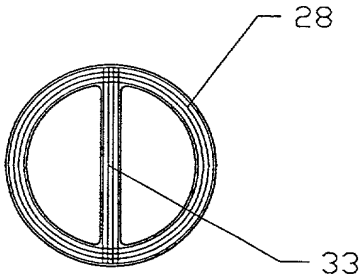

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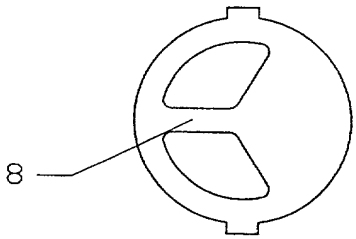

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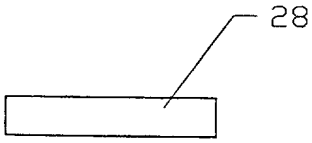

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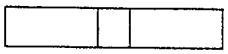

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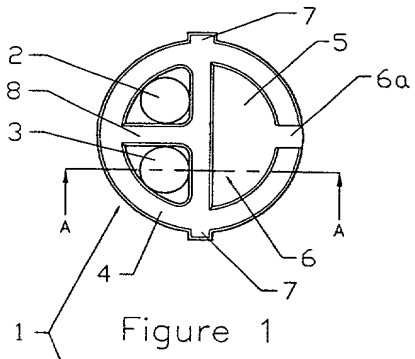
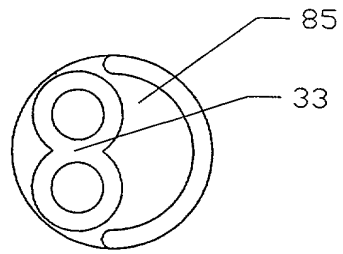


Figure 1



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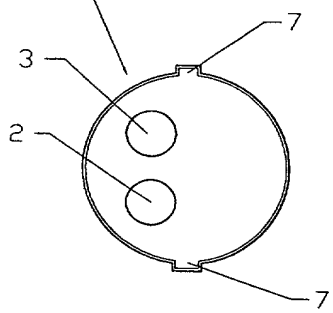

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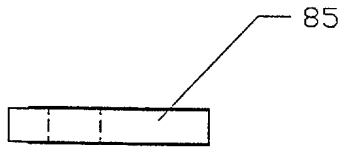

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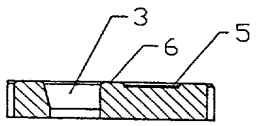

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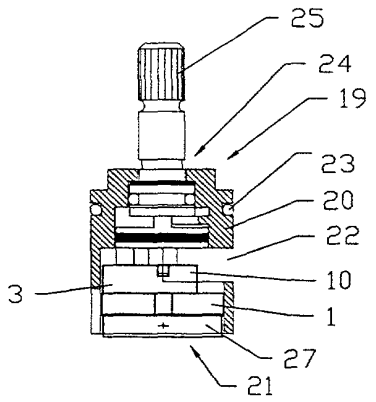

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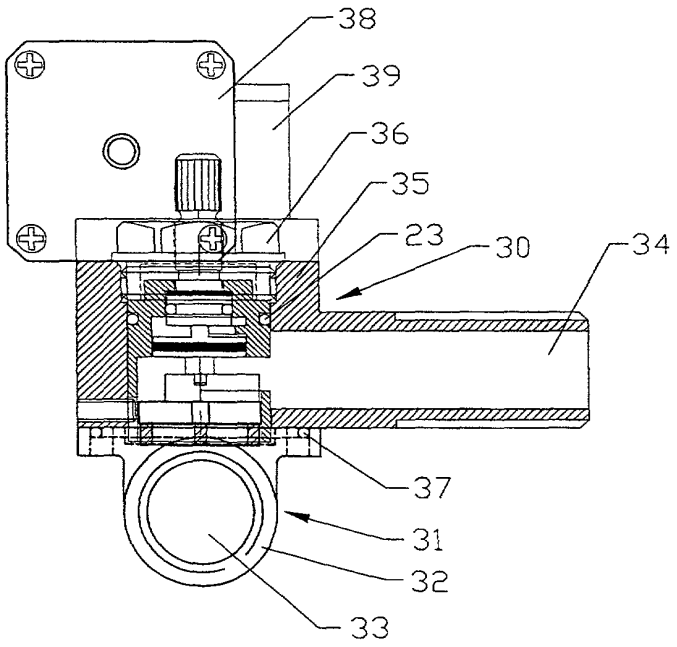

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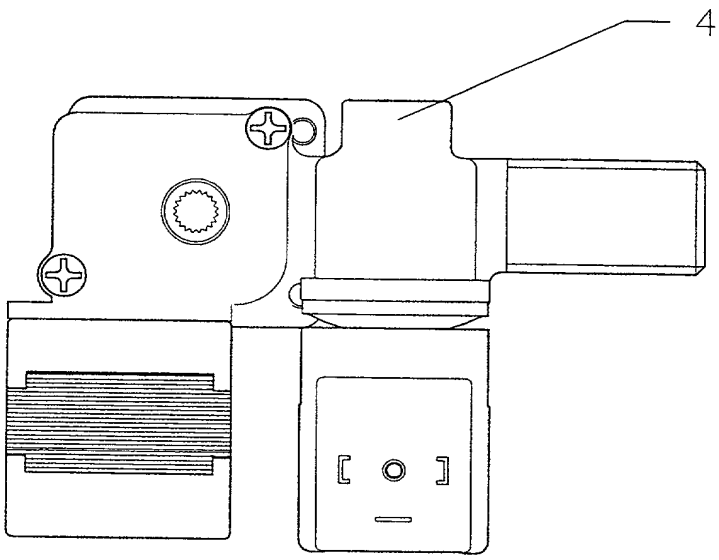
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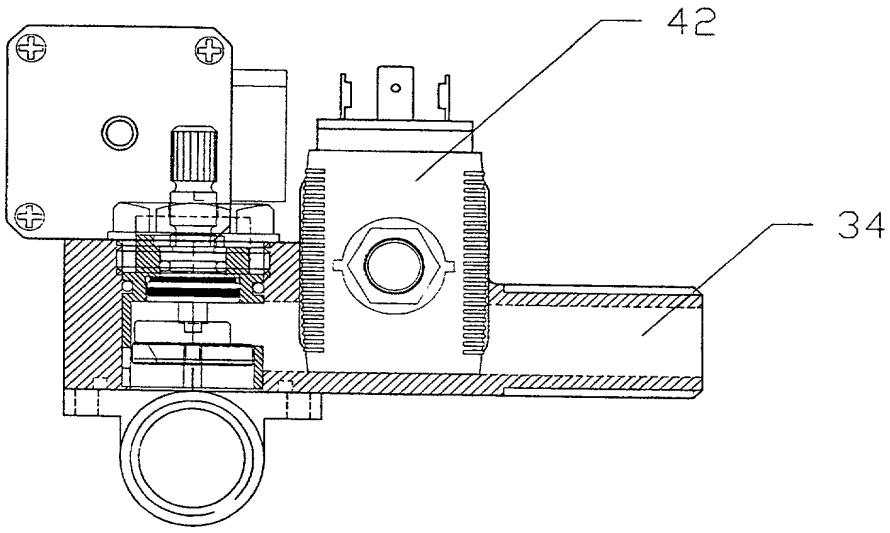
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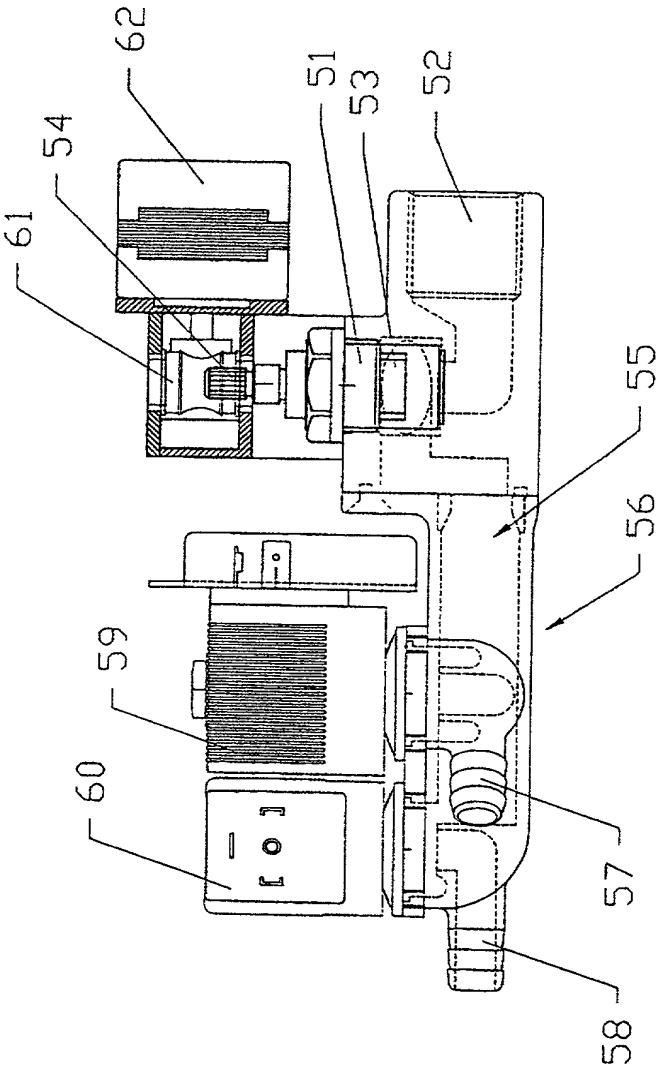
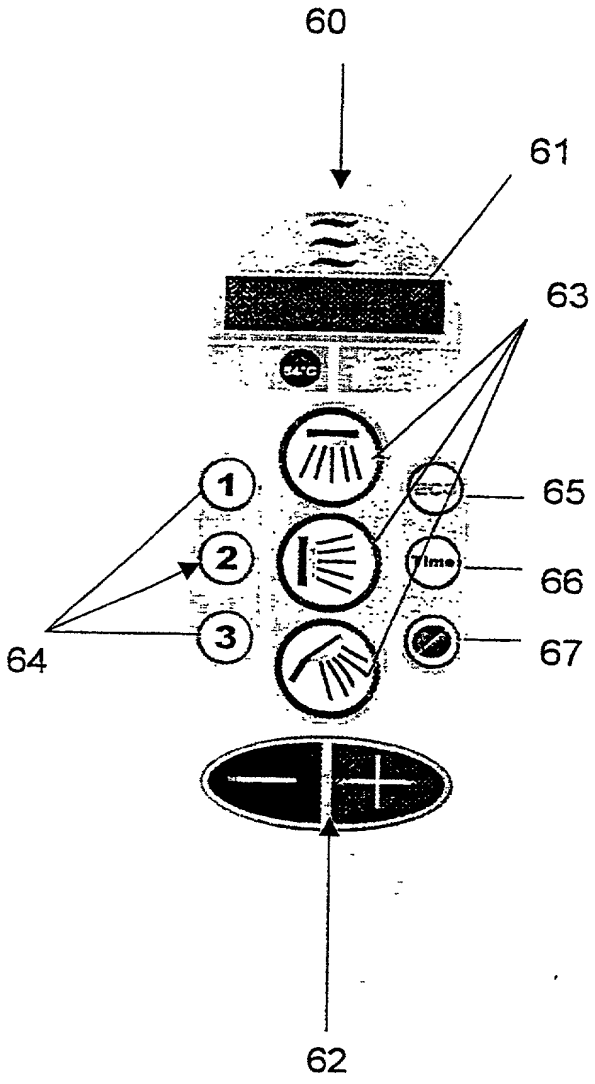


Figure 14

Fig 15



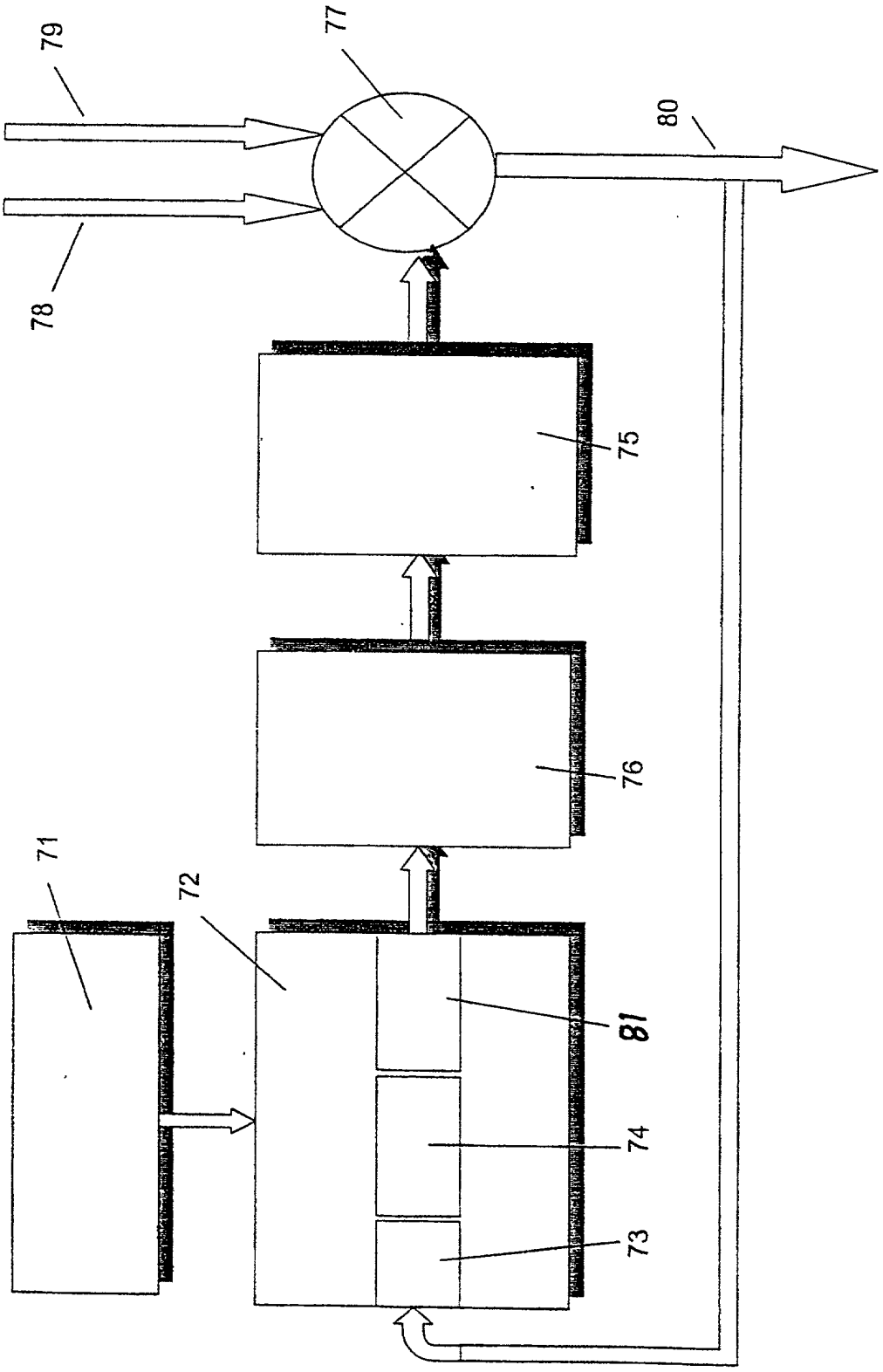


Figure 16

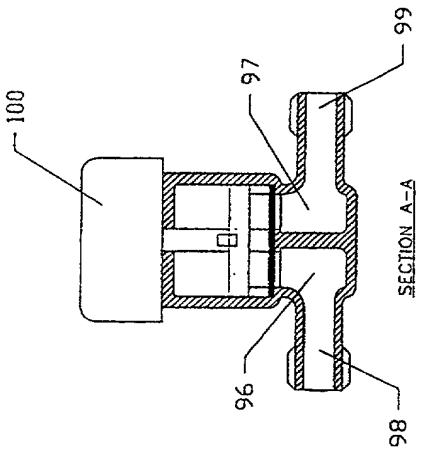
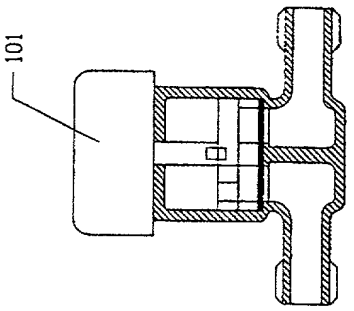


Figure 18



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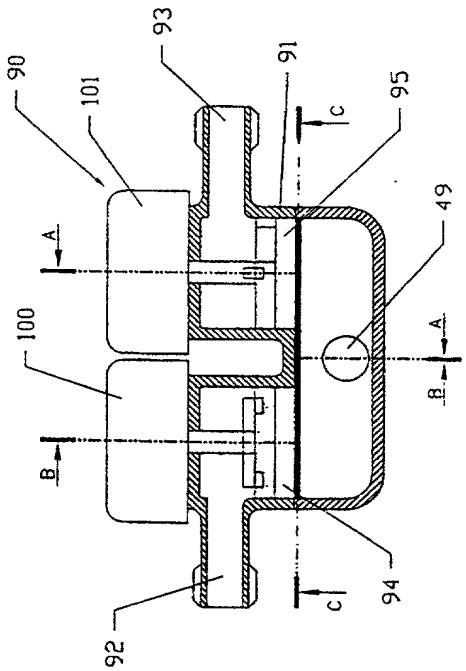

Figure 17

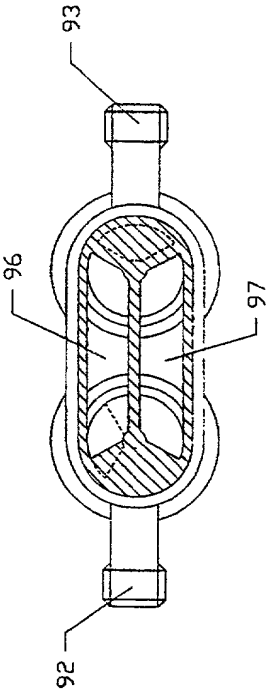

Figure 19

Attorney Docket No. 8436.63USWO

MERCHANT & GOULD P.C.

United States Patent Application

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: VALVE SYSTEM FOR SERVO CONTROL OF FLUID FLOWS

The specification of which
a. ☐ is attached hereto
b. ☒ was filed on 11 June 1999 as application serial no. and was amended on 11 June 1999 (if applicable) (in the case of a PCT-filed application) described and claimed in international no. PCT/NZ97/00168 filed 12 December 1997 and as amended on 17 February 1999 (if any), which I have reviewed and for which I solicit a United States patent.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (attached hereto).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on the basis of which priority is claimed:

a. ☐ no such applications have been filed.
b. ☒ such applications have been filed as follows:

FOREIGN APPLICATION(S), IF ANY, CLAIMING PRIORITY UNDER 35 USC § 119			
COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)
NEW ZEALAND	299927	12 December 1996	
ALL FOREIGN APPLICATION(S), IF ANY, FILED BEFORE THE PRIORITY APPLICATION(S)			
COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)

I hereby claim the benefit under Title 35, United States Code, § 120/365 of any United States and PCT international application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

U.S. PROVISIONAL APPLICATION NUMBER	DATE OF FILING (Day, Month, Year)

I hereby appoint the following attorney(s) and/or patent agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith:

Albrecht, John W.	Reg. No. 40,481	Lacy, Paul E.	Reg. No. 38,946
Anderson, Gregg I.	Reg. No. 28,828	Larson, James A.	Reg. No. 40,443
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Batzli, Brian H.	Reg. No. 32,960	Liepa, Mara E.	Reg. No. 40,066
Beard, John L.	Reg. No. 27,612	Lindquist, Timothy A.	Reg. No. 40,701
Black, Bruce E.	Reg. No. 41,622	Lynch, David W.	Reg. No. 36,204
Blasdell, Thomas L.	Reg. No. 31,329	Marschang, Diane L.	Reg. No. 35,600
Bogucki, Raymond A.	Reg. No. 17,426	McDaniel, Karen D.	Reg. No. 37,674
Bruess, Steven C.	Reg. No. 34,130	McDonald, Daniel W.	Reg. No. 32,044
Byrne, Linda M.	Reg. No. 32,404	McIntyre, Iain A.	Reg. No. 40,337
Carlson, Alan G.	Reg. No. 25,959	Mueller, Douglas P.	Reg. No. 30,300
Caspers, Philip P.	Reg. No. 33,227	Nelson, Albin J.	Reg. No. 28,650
Chiapetta, James R.	Reg. No. 39,634	Pauly, Daniel M.	Reg. No. 40,123
Clifford, John A.	Reg. No. 30,247	Phillips, John B.	Reg. No. 37,206
Cochran, William W.	Reg. No. 26,652	Plunkett, Theodore	Reg. No. 37,209
Daignault, Ronald A.	Reg. No. 25,968	Pytel, Melissa J.	Reg. No. 41,512
Daley, Dennis R.	Reg. No. 34,994	Reich, John C.	Reg. No. 37,703
Dalglish, Leslie E.	Reg. No. 40,579	Reiland, Earl D.	Reg. No. 25,767
Daulton, Julie R.	Reg. No. 36,414	Rittmaster, Ted R.	Reg. No. 32,933
DeVries Smith, Katherine M.	Reg. No. 42,157	Schmaltz, David G.	Reg. No. 39,828
DiPietro, Mark J.	Reg. No. 28,707	Schuman, Mark D.	Reg. No. 31,197
Edell, Robert T.	Reg. No. 20,187	Schumann, Michael D.	Reg. No. 30,422
Epp Ryan, Sandra	Reg. No. 39,667	Scull, Timothy B.	Reg. No. 42,137
Funk, Steven R.	Reg. No. 37,830	Sebald, Gregory A.	Reg. No. 33,280
Glance, Robert J.	Reg. No. 40,620	Skoog, Mark T.	Reg. No. 40,178
Golla, Charles E.	Reg. No. 26,896	Soderberg, Richard	Reg. No. P-43,352
Gorman, Alan G.	Reg. No. 38,472	Sumner, John P.	Reg. No. 29,114
Gould, John D.	Reg. No. 18,223	Sumners, John S.	Reg. No. 24,216
Gregson, Richard	Reg. No. 41,804	Tellekson, David K.	Reg. No. 32,314
Gresens, John J.	Reg. No. 33,112	Trembath, Jon R.	Reg. No. 38,344
Hamre, Curtis B.	Reg. No. 29,165	Underhill, Albert L.	Reg. No. 27,403
Hillson, Randall A.	Reg. No. 31,838	Vandenburgh, J. Derek	Reg. No. 32,179
Holzer, Jr., Richard J.	Reg. No. 42,668	Vradenburgh, Anna M.	Reg. No. 39,868
Johnston, Scott W.	Reg. No. 39,721	Welter, Paul A.	Reg. No. 20,890
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Kastelic, Joseph M.	Reg. No. 37,160	Wickhem, J. Scot	Reg. No. 41,376
Kettelberger, Denise	Reg. No. 33,924	Williams, Douglas J.	Reg. No. 27,054
Knearl, Homer L.	Reg. No. 21,197	Witt, Jonelle	Reg. No. 41,980
Kowalchyk, Alan W.	Reg. No. 31,535	Wood, William J.	Reg. No. 42,236
Kowalchyk, Katherine M.	Reg. No. 36,848	Xu, Min S.	Reg. No. 39,536
Kubota, Glenn M.	Reg. No. 44,197		

I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct Merchant & Gould P.C. to the contrary.

Please direct all correspondence in this case to Merchant & Gould P.C. at the address indicated below:

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§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)–(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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